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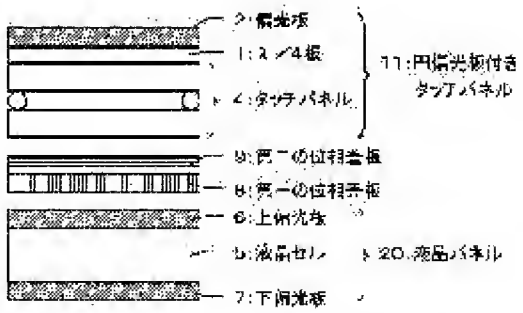
(54) DEVICE FOR LIQUID CRYSTAL DISPLAY

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the coloring in an oblique direction while maintaining the display quality of the front face in an liquid crystal display device on which a transparent protective plate such as a touch panel is arranged.

SOLUTION: The liquid crystal display device which is constituted so that a laminated protective panel (for example a touch panel 11 with circularly polarizing plate), consisting of a λ/4 plate 1, a polarizing plate 2 and the transparent protective plate (for example the touch panel 4), is arranged on the upper surface of a liquid crystal panel 20 with a certain interval and at least two sheets of optical retardation plates 8, 9 are arranged between the laminated protective panel 11 and the liquid crystal panel 20, is provided.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the liquid crystal display which has a transparent protective plate.
In detail, it has a guard plate and is related with the liquid crystal display in which a luminosity, visibility, and a view angle characteristic were improved.

[0002]
[Description of the Prior Art]The pen input art which can be operated with the feeling which writes to paper with a pencil from the flow of diversification of information machines and equipment and the small weight saving of a personal digital assistant is becoming important, and the display possessing a touch panel of the input display integral type is used widely. Although all directions types, such as a optical type, an ultrasonic system, a resistance film system, an electric capacity type, and electromagnetic guidance, are put in practical use as this touch panel, also in which method, the transparent protective plate is usually used for the upper surface for [for input signal detection] screen protection. That is, a transparent protective plate is formed in the upper surface of a touch panel, or the transparent protective plate itself constitutes a touch panel. Although many liquid crystal displays of thin small power are used for the display, since orientation defects will be produced if an external shock is received, the strong dielectric liquid crystal panel has also played the role with which the transparent protective plate arranged at the front face protects a liquid crystal layer from this external shock.
[0003]In the liquid crystal display which has such a transparent protective plate, there is not only the surface reflection from a liquid crystal display panel but reflection from a transparent protective plate, and a display becomes very hard to see on the bright interior of a room or

outdoors. In order to solve the problem of such visibility, use of the circular light board which is the combination of lambda/4 board and a polarizing plate is proposed by the publication-number 5 No. -127822 gazette. Publication number lambda/4 another board is arranged between the touch panel and liquid crystal display which have a circular light board, and the method of improving display quality is proposed by the 10-48625 item gazette. It is indicated that lambda/4 board other than lambda/4 board which constitutes a circular light board in the latter gazette is arranged so that both oriented axis (optic axis) may become in the direction or it may intersect perpendicularly, and it is supposed that it is preferred to arrange in the direction which merely intersects perpendicularly from the goodness of visibility.

[0004]

[Problem(s) to be Solved by the Invention]However, in the composition which makes the oriented axis of lambda/4 board other than lambda/4 board which constitutes a circular light board in this way intersect perpendicularly, and makes phase contrast offset, when it saw from across, it turned out that there is a problem to which a display becomes yellow. Visibility will be inferior as it is indicated also in the above-mentioned gazette, when arranging two lambda/4 boards so that both oriented axis may become parallel, and operating them as lambda/2 board.

[0005]Then, by arranging the phase difference plate of at least two sheets between a guard plate and a liquid crystal panel apart from lambda/4 board for which a circular light board is constituted, as a result of inquiring wholeheartedly, in order that this invention person may solve such a problem, Maintaining front display quality, it found out that coloring of an oblique direction was improvable, and resulted in this invention.

[0006]

[Means for Solving the Problem]That is, this invention provides a liquid crystal display in which a lamination protective panel of lambda/4 board, a polarizing plate, and a transparent protective plate establishes an interval, and is arranged at the upper surface of a liquid crystal panel, and a phase difference plate of at least two sheets is arranged between a lamination protective panel and a liquid crystal panel.

[0007]

[Embodiment of the Invention]Hereafter, it explains still in detail about this invention, also referring to drawings. Drawing 1 - drawing 3 are the sectional views showing some examples typically about the lamination of the liquid crystal display concerning this invention among a drawing. Drawing 4 and drawing 5 show the concept of the polarization conversion at the time of using the liquid crystal panel which emits 45-degree linear polarization on the Poincare sphere, Drawing 4 lambda/4 board which constitutes a circular light board, and the phase difference plate between a lamination protective panel and a liquid crystal panel according to conventional technology, Expressing the case where it has arranged so that each oriented axis

may intersect perpendicularly, drawing 5 expresses the case where dislocated each oriented axis and the phase difference plate of two sheets has been arranged according to this invention between a lamination protective panel and a liquid crystal panel besides lambda/4 board which constitutes a circular light board. Drawing 6 is a figure for explaining the arrangement angle of the oriented axis of lambda/4 board thru/or a phase difference plate, and the absorption axis of a polarizing plate. In the example mentioned later, drawing 7 is a sectional view showing typically the lamination at the time of applying this invention to a resistance film type touch panel.

[0008]In the liquid crystal display shown in drawing 1 - drawing 3, the lambda/4 board 1 and the polarizing plate 2 are together put so that each optical axis may make the angle of about 45 degrees relatively, and they form the circular light board. This circular light board functions as an acid-resisting filter which absorbs efficiently the internal reflection by the incident light from the outside. A circular light board may be arranged at the front face of the transparent protective plate 3, as shown in drawing 1, as shown in drawing 2, it may be arranged at the back, and as shown in drawing 3, it may dissociate and it may be arranged. These lambda/4 boards 1, the polarizing plate 2, and the transparent protective plate 3 constitute the lamination protective panel 10. On the other hand, although the liquid crystal panel 20 usually comprises the upper polarizing plate 6 and the lower polarizing plate 7 which are arranged to the liquid crystal cell 5 and its both sides, it is also possible to omit the upper polarizing plate 6. When thinking a luminosity as important, the upper polarizing plate 6 has preferred how to twist, and when thinking contrast as important conversely, a certain direction of the upper polarizing plate 6 is preferred.

[0009]The polarizing plate 2 can be what is usually used in the liquid-crystal-display field, For example, the uniaxial stretched film etc. in which adsorption orientation of a dichroism substance like iodine or dichromatic dye was carried out are suitable for polyvinyl alcohol system resin, and it is used for both sides of the uniaxial stretched film in which adsorption orientation of this dichroism substance was usually carried out where a protective film is laminated. The same may be said of the upper polarizing plate 6 and the lower polarizing plate 7 which constitute the liquid crystal display panel 20.

[0010]When the transparent protective plate 3 is arranged at the polarizing plate 2 bottom, as for this guard plate 3, it is preferred that it is an isotropic material optically, and glass, the high polymer film of non-orientation, etc. are suitable. The transparent protective plate 3 may be a touch panel. When it is a resistance film system touch panel, the lambda/4 board 1 and the polarizing plate 2 could form the direct-current-resistance film, and may serve as the member which constitutes a touch panel.

[0011]In this invention, the phase difference plate of at least two sheets is arranged between the protective panel 10 and the liquid crystal panel 20 in which the lambda/4 board 1, the

polarizing plate 2, and the transparent protective plate 3 were laminated. Drawing 1 - drawing 3 show the example which has arranged the phase difference plates 8 and 9 of two sheets. These phase difference plates 8 and 9 should just be between the lamination protective panel 10 and the liquid crystal panel 20, may be pasted together by the back of the lamination protective panel 10, and may be pasted together by the front face of the liquid crystal panel 20. Of course, the first phase difference plate 8 is pasted together in the front face of the liquid crystal panel 20, and it may be made to paste the second phase difference plate 9 together at the back of the lamination protective panel 10. It is only available to place these phase difference plates 8 and 9 between the laminated panel 10 and the liquid crystal panel 20. However, as for these phase difference plates 8 and 9, from a viewpoint of the acid-resisting effect, it is preferred to paste together on the surface of a liquid crystal panel.

[0012]These phase difference plates 8 and 9 are arranged in order that the display light from the liquid crystal panel 20 may penetrate efficiently the lamination protective panel 10 in which the circular light board was formed with the lambda/4 board 1 and the polarizing plate 2. Said publication number So that the lambda/4 board 1 and oriented axis which constitute the lamination protective panel 10 may intersect perpendicularly as proposed in the 10-48625 item gazette, One lambda/4 another board is arranged between the lamination protective panel 10 and the liquid crystal panel 20, Since a transverse-plane retardation is offset when it has arranged so that the absorption axis of the polarizing plate 2 and the upper polarizing plate 6 of the liquid crystal panel 20 which constitute the lamination protective panel 10 may become parallel, the display light seen from the transverse plane penetrates a guard plate efficiently, and gives good display quality. However, in the composition composition and such two phase difference films cross at right angles, when it sees from across, it will be the display light which is tinged with yellowness from the influence by the angle variation of a retardation. The retardation of one lambda/4 board increases this in an oblique direction, and since the retardation of another lambda/4 board decreases, it is because a retardation is no longer offset.

[0013]Then, so that the red contained in the display light from the liquid crystal panel 20 and the circular light board with which all the green and blue three primary colors constitute the lamination protective panel 10 may be efficiently penetrated in this invention, The phase difference plate of at least two sheets is arranged between the lamination protective panel 10 and the liquid crystal panel 20, and it has the feature at the point which carries out polarization conversion. That is, in consideration of the wavelength dispersion of lambda/4 board and phase difference plate to be used, it is changed into red and the linear polarization in which all the green and blue three primary colors are almost the same, and it optimizes so that the lamination protective panel 10 may be penetrated.

[0014]red (R) when drawing 4 and drawing 5 use the liquid crystal panel which emits 45-

degree linear polarization, and green -- (G) and blue -- the locus of polarization conversion is typically shown about the three primary colors of (B) on the Poincare sphere (surface of a sphere which makes the state of polarization correspond to one on a surface of a sphere, and displays it). The equator expresses the linear polarization state of each vibrating direction with the Poincare sphere, and the North Pole and the south pole express the circular light state with it. In drawing 4 and drawing 5, it is a dashed line about the locus of red polarization conversion among the three primary colors, and is a solid line about the locus of green polarization conversion, and the locus of blue polarization conversion is expressed with the dashed dotted line, respectively. The locus of red when it passes along the phase difference plate of the first sheet, and green and blue polarization conversion is expressed with R1, G1, and B1, respectively, The locus of red when it passes along a handsome phase difference plate (drawing 4 lambda/4 board), and green and blue polarization conversion is expressed with R2, G2, and B-2, respectively, and the locus of red when it passes along the phase difference plate (lambda/4 board) of an actor playing a comic role by drawing 5, and green and blue polarization conversion is expressed with R3, G3, and B3, respectively. It starts from the place same originally also as red, green, and blue, after passing the phase difference plate of two sheets or three sheets, it arrives at the same place, but the start position and the last arrival position are shifted and displayed on right and left from the convenience of the graphic display on a flat surface.

[0015]When one lambda/4 board has been arranged between the lamination protective panel 10 and the liquid crystal panel 20 so that the lambda/4 board 1 and oriented axis which constitute the lamination protective panel 10 may intersect perpendicularly, as shown in drawing 4, the same locus is followed and it returns to the original polarization condition. In a common phase difference plate, since light with shorter wavelength is in the tendency for phase contrast to become large, in the three primary colors, phase contrast appears greatly most in blue glow, and, subsequently to the order of green light and red light, phase contrast becomes small, but all will follow the same locus and will return to the original polarization condition. On the other hand, when the phase difference plate of two sheets has been arranged at an angle of predetermined between the lamination protective panel 10 and the liquid crystal panel 20 according to this invention. For example, as shown in drawing 5, 45-degree linear polarization is changed by the first phase difference plate 8 like B1 in blue glow like G1 in green light like R1 in red light, respectively. Since red light, green light, and blue glow distribute in that case, while, conversion is performed by return by the second phase difference plate 9 to R2, G2, and B-2, respectively so that it may become the circular light which suited the wavelength dispersion of the lambda/4 board 1 which constitutes the lamination protective panel 10. Finally conversion will be performed by the lambda/4 board 1 which constitutes a lamination protective panel R3, G3, and B3, and red and the green and

blue three primary colors will penetrate the lamination protective panel 10 efficiently.
[0016]Thus, by repeating at least three conversion, even if it does not offset a retardation, a good display comes to be obtained. As explained above, the angle variation of the retardation of lambda/4 board which constitutes a circular light board, and the phase difference plate arranged on a liquid crystal panel has influenced the yellowness from an oblique direction, but. In composition which is arranged like this invention at an angle with two or more various phase difference plates 8 and 9, the influence which it has to the polarization conversion of each retardation change tends to be reduced. Therefore, in this invention, a color change when a liquid crystal display is seen from an oblique direction can be improved now.
[0017]Then, as for the phase difference plate of at least two sheets arranged between the lambda/4 board 1 which constitutes a circular light board and the lamination protective panel 10, and the liquid crystal panel 20, it is preferred not to arrange so that a mutual oriented axis may become parallel, but to give a certain amount of angle mutually. For example, when using the phase difference plates 8 and 9 of two sheets like drawing 1 - 3, As for the oriented axis of the lambda/4 board 1, it is preferred that it is between the oriented axes of the first phase difference plate 8 and the second phase difference plate 9, and it is preferred that the oriented axis of one phase difference plate arranges to the oriented axis of the lambda/4 board 1 further so that the oriented axis of the phase difference plate of about +10-+80 degrees and another side may be about -10--80 degree. As for the phase difference plates 8 and 9 of two sheets, although it is not necessary to make symmetrical the oriented axis of the phase difference plates 8 and 9 of two sheets a center [the oriented axis of the lambda/4 board 1], it is preferred to arrange so that both oriented axis may be not less than about 30 degrees. What is necessary is just to arrange so that an oriented axis may cross at the angle in which it is also the same as when using the phase difference plate of three or more sheets, and they and the lambda/4 board 1 are suitable respectively.
[0018]What has a the same retardation may be used especially for the retardation of the phase difference plate of at least two sheets arranged between the lamination protective panel 10 and the liquid crystal panel 20 as a phase difference plate of at least two sheets which is not limited, for example, is arranged here. However, if it carries out from a viewpoint of reducing wavelength dispersion, when using the phase difference plates 8 and 9 of two sheets like drawing 1 - 3, for example, It is preferred to arrange lambda/4 board whose retardation is about 100-175 nm on it (lamination protective panel 10 side) using lambda/2 board whose retardation is about 200-350 nm as the first phase difference plate 8 by the side of the liquid crystal panel 20. For example, lambda board can also be used as the first phase difference plate 8 (3/2).
[0019]The lambda/4 board 1 and the phase difference plates 8 and 9 of at least two sheets which are used for this invention, Although it can be an uniaxial stretched film of the various

polymeric materials generally adopted in the liquid-crystal-display field and polyvinyl alcohol, norbornene system resin, cellulose type resin, polycarbonate, etc. are mentioned as the raw material, for example, of course, it is not necessarily limited to these. As the lambda/4 board 1 and the phase difference plates 8 and 9, the direction of material with small wavelength dispersion of a retardation is in the tendency for a better optical property to be obtained. The wavelength dispersion of a retardation means the changing ratio of the retardation by change of a measured wavelength here, For example, if the retardation in the measured wavelength of 450 nm is made into R_{450} and the retardation in the measured wavelength of 590 nm is made into R_{590}, the wavelength dispersion alpha of a retardation can be expressed with a following formula, and will serve as a value peculiar to material.

[0020]Alpha=R_{450}/R_{590}[0021]An option can also be given to the surface of the lamination protective panel 10 in the liquid crystal display of this invention. For example, it gets damaged on the surface and the transparent hard court layer for prevention can be provided. A hard court layer can be formed by spreading, or can be formed by pasting of a hard court film. Since reflection of outdoor daylight is prevented, the anti glare layer which forms detailed unevenness in the surface and to which scattered reflection of the outdoor daylight is carried out, and the antireflection layer which consists of a multilayer film of dielectric membrane can also be formed. The transparent hard court film in which the antireflection layer was formed can be pasted together, or an antireflection layer can also be formed on a hard court layer.

[0022]

[Example]This invention is not limited by these examples, although an example is shown and this invention is explained still in detail hereafter. In these examples, as shown in drawing 6, the oriented axis of lambda/4 board thru/or a phase difference plate and the absorption axis of a polarizing plate make 0 degree a certain direction (a figure transverse direction), and they display it so that an angle may progress counter clockwise. The retardation values in an example are values in the measured wavelength of 550 nm.

[0023]Example 1 -- here, using an isotropic resistance film type touch panel as a transparent protective plate, It is shown in drawing 7, and also the touch-sensitive liquid crystal display which becomes order from the lamination of (polarizing plate 2)/(lambda/4 board 1)/(touch panel 4)/(second phase difference plate 9)/(first phase difference plate 8)/(liquid crystal panel 20) is explained, quoting the number in a figure suitably for an example from from.

[0024]lambda/4 board made from polycarbonate currently sold in Sumitomo Chemical Co., Ltd. "SEF340138B" (retardation values of 138 nm) The oriented axis used as the lambda/4 board 1 was 90 degrees, both were pasted together so that the absorption axis of the polarizing plate 2 might be 45 degrees, the lambda/4 board 1 side was further pasted together to the upper surface of the isotropic resistance film type touch panel 4, and it was considered as the touch

panel 11 with a circular light board. On the other hand, the absorption axis of the upper polarizing plate 6 on the surface of the liquid crystal panel 20 arranged at 135 degrees. The phase difference plate made from polycarbonate currently sold in Sumitomo Chemical Co., Ltd. "SEF460275B" (retardation values of 275 nm) the first phase difference plate 8 -- carrying out -- it pasting together so that an oriented axis may be 60 degrees, and, Another phase difference plate made from polycarbonate "SEF340120B" (it is considered as retardation values of 120 nm and the second phase difference plate 9) currently furthermore sold in the company on it was pasted together so that an oriented axis might be 120 degrees. In this way, the above-mentioned touch panel 11 with a circular light board has been arranged on the upper surface (second phase difference plate 9 side) of the liquid crystal panel 20 in which the phase difference plates 8 and 9 of two sheets were pasted together so that the touch panel 4 may turn down, and it was made it with the touch-sensitive liquid crystal display.

[0025]The oriented axis of lambda/4 board made from polycarbonate "SEF340138B" (retardation values of 138 nm) currently sold in comparative example 1 Sumitomo Chemical Co., Ltd. shall be 0 degree, Both were pasted together so that the absorption axis of a polarizing plate might be 135 degrees, the its lambda / 4 board side was further pasted together to the upper surface of the isotropic resistance film type touch panel 4, and it was considered as the touch panel with a circular light board. On the other hand, the absorption axis of an upper polarizing plate on the surface of the liquid crystal panel arranged at 135 degrees. the about the same as a top -- pasting together a phase reference board "SEF340138B" (retardation values of 138 nm) so that an oriented axis may be 90 degrees -- the -- the upper (phase difference plate side) -- the above-mentioned touch panel with a circular light board has been arranged so that a touch panel may turn down, and it was used as the touch-sensitive liquid crystal display. This liquid crystal display has the same lamination as drawing 7, except that the number of the phase difference plates 8 and 9 is one.

[0026]Front brightness of the comparative example 1 is made into 100%, and the luminosity of the direction of right 40 degree, the front brightness of Example 1, and the luminosity of the direction of right 40 degree are shown in Table 1 with a relative value.

[0027]

[Table 1]

----------. Example The degree of No. phase difference plate axial angle The evaluation direction Blue Green Red (opposite lambda / 4 board) 435 nm 545 nm 612 nm. ----------. Example 1 first : - 30 degree front-direction 97 % 100 % 99 % the 2: + 30 " Direction [of right 40 degree] 42 % 45 % 51 %. ---------- ---------- comparative example 1 One sheet : 90 degrees Direction [of front direction 100 % 100 % 100 % right 40 degree] 33 % 44 % 48 %----------[0028]As shown also in Table 1, by the comparative example 1, the lateral luminosity of the good thing was insufficient for the front display, and

when it saw from a transverse direction, the color change of it was carried out yellow. On the other hand, in Example 1, it was good, the front display had few color changes, also when it saw from a transverse direction, and it had a large angle of visibility.

[0029]

[Effect of the Invention]According to this invention, it can be considered as liquid crystal displays, such as a touch-panel method which were provided with the acid-resisting function and was excellent in visibility, and a view angle characteristic can also be improved.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a sectional view showing typically an example of the lamination of the liquid crystal display concerning this invention.
[Drawing 2]It is a sectional view showing the example of another lamination typically.
[Drawing 3]It is a sectional view showing the example of another lamination typically.
[Drawing 4]It is a figure showing typically the locus of the polarization conversion on the Poincare sphere in the case of having arranged lambda/4 board which constitutes a circular light board, and the phase difference plate between a lamination protective panel and a liquid crystal panel so that each oriented axis may intersect perpendicularly.
[Drawing 5]It is a figure showing typically the locus of the polarization conversion on the Poincare sphere in the case of having arranged the phase difference plate of two sheets between a lamination protective panel and a liquid crystal panel besides lambda/4 board which constitutes a circular light board.
[Drawing 6]It is a figure for explaining the arrangement angle of the oriented axis of lambda/4 board thru/or a phase difference plate, and the absorption axis of a polarizing plate.
[Drawing 7]In an example, it is a sectional view showing typically the lamination at the time of applying this invention to a resistance film type touch panel.
[Description of Notations]
1 .... lambda/4 board,
2 .... Polarizing plate,
3 .... Transparent protective plate,
4 .... Touch panel,
5 .... Liquid crystal cell
6 .... Upper polarizing plate,
7 .... Lower polarizing plate,

8 .... The first phase difference plate,
9 .... The second phase difference plate,
10 .... Lamination protective panel,
11 .... Touch panel with a circular light board,
20 .... Liquid crystal panel
R1, R2, R3 .... Locus of the red polarization on the Poincare sphere,
G1, G2, G3 .... Locus of the green polarization on the Poincare sphere,
B1, B-2, B3 .... Locus of the blue polarization on the Poincare sphere.

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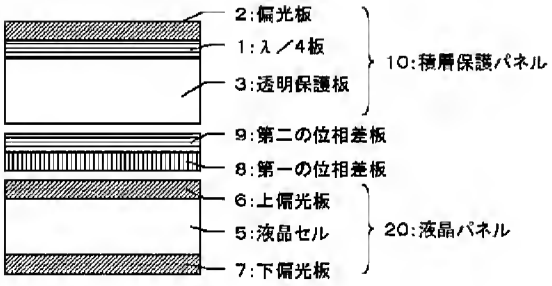
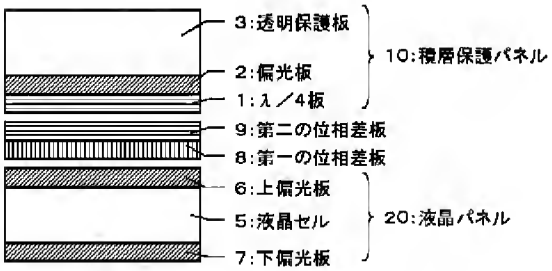
DRAWINGS

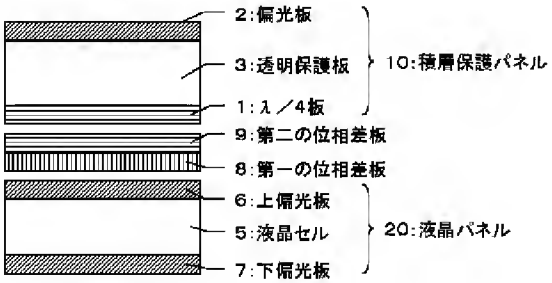
[Drawing 1]



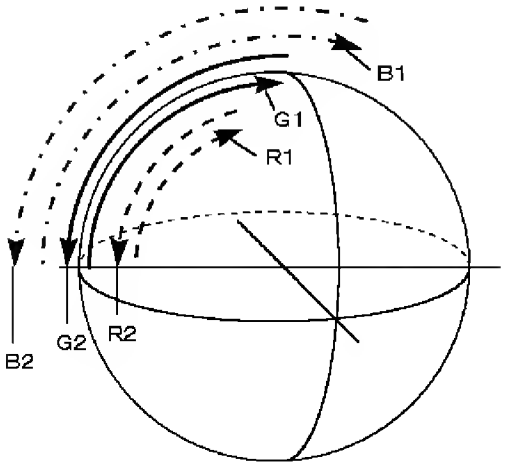
[Drawing 2]



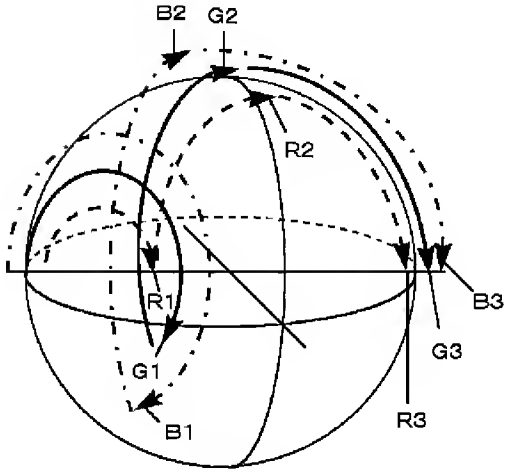
[Drawing 3]



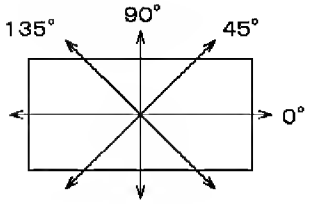
[Drawing 4]



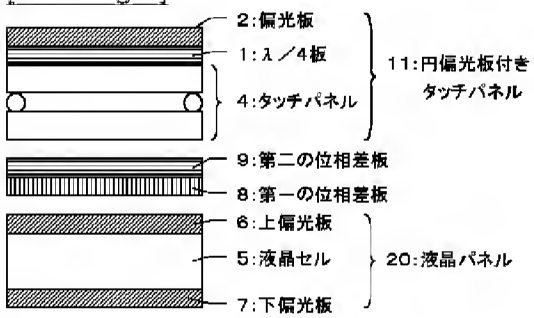
[Drawing 5]



[Drawing 6]



[Drawing 7]



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CLAIMS

[Claim(s)]
[Claim 1]A liquid crystal display, wherein a lamination protective panel of lambda/4 board, a polarizing plate, and a transparent protective plate establishes an interval, and is arranged at the upper surface of a liquid crystal panel and a phase difference plate of at least two sheets is arranged between this lamination protective panel and a liquid crystal panel.
[Claim 2]The liquid crystal display according to claim 1 in which a transparent protective plate is arranged in a lamination protective panel at the liquid crystal panel side.
[Claim 3]The liquid crystal display according to claim 1 in which lambda/4 board is arranged in a lamination protective panel at the liquid crystal panel side.
[Claim 4]The liquid crystal display according to any one of claims 1 to 3 in which an upper polarizing plate does not exist in a liquid crystal panel.
[Claim 5]The liquid crystal display according to any one of claims 1 to 4 whose transparent protective plate is a touch panel.
[Claim 6]The liquid crystal display according to any one of claims 1 to 5 in which the number of phase difference plates arranged between a lamination protective panel and a liquid crystal panel is two, and an oriented axis of one phase difference plate is making +10 degrees - +80 degrees, and an angle whose oriented axis of a phase difference plate of another side is -10 degree--80 degree to an oriented axis of lambda/4 board.
[Claim 7]The liquid crystal display according to any one of claims 1 to 6 arranged from the liquid crystal panel side in order of lambda/2 board and lambda/4 board by a phase difference plate consisting of two sheets, lambda/2 board and lambda/4 board.
[Claim 8]The liquid crystal display according to any one of claims 1 to 7 in which a lamination protective panel has a hard court layer in the outermost surface.
[Claim 9]The liquid crystal display according to any one of claims 1 to 7 in which a lamination protective panel has an antireflection layer in the outermost surface.

[Translation done.]